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TRADE DISRUPTIONS AND AMERICA'S EARLY INDUSTRIALIZATION

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ABSTRACT

Between 1807 and 1815, U.S. imports of manufactured goods were severely cut by Jefferson's trade embargo, subsequent non-importation measures, and the War of 1812. These disruptions are commonly believed to have spurred early U.S. industrialization by promoting the growth of nascent domestic manufacturers. This paper uses a newly available series on U.S. industrial production to investigate how this protection from foreign competition affected domestic manufacturing. On balance, the trade disruptions did not decisively accelerate U.S. industrialization as trend growth in industrial production was little changed over this period. However, the disruptions may have played a limited role in shifting resources from trade-dependent industries (such as shipbuilding) to domestic infant industries (such as cotton textiles).

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Trade Disruptions and America's Early Industrialization

1. Introduction

Between 1807 and 1815, U.S. foreign trade was severely disrupted by Jefferson's trade embargo, subsequent non-importation measures, and the British blockade during the War of 1812. These disruptions prevented foreign manufactured goods from reaching the U.S. market, thereby protecting nascent domestic industries from import competition. As a result, new manufacturing firms were established and existing domestic producers rapidly expanded output to replace previously imported goods. When normal commerce resumed in 1815, however, a flood of imported manufactured goods (mainly from Britain) threatened to eliminate many of the new producers and set back any gains to domestic manufacturers. Although it came too late to save many of the recent domestic entrants, the tariff of 1816 helped stem the flow of imports and stabilize the situation.

This version of events is widely accepted; economic historians have no reason to doubt that, by keeping British manufactured goods out of the U.S. market, the trade disruptions helped stimulate domestic production by import-competing industries. An open question, however, is whether the seven-year trade disruption decisively accelerated America's industrialization, despite the setback in 1815, or merely provided a temporary and short-lived boost to some domestic manufacturers. Limited data on early U.S. industries have prevented any clear cut answer from emerging. Older works document to the blossoming of manufacturing around this period, but mainly provide descriptive evidence from the period.[1] More recent research has

[1] For example, Taussig (1931, pp. 16-17) observed that a "series of restrictive measures blocked the accustomed channels of exchange and production, and gave an enormous stimulus to those branches of industry whose products had before been imported. Establishments for the manufacture of cotton goods, woollen cloths, iron, glass, pottery, and other articles, sprang up with a mushroom growth. . . . It is sufficient here to note that the restrictive legislation of 1808-

provided some limited quantitative evidence by focusing on indirect measures of manufacturing activity, such as incorporations or patents, both of which increased as well.[2] But the lack of data from the period has impeded efforts to determine precisely how the trade disruptions affected the American economy.

This paper addresses the question of how the trade disruptions affected early U.S. manufacturing by using a new index of industrial production by Davis (2002). The index can be decomposed into its constituent elements, permitting a more refined look at the impact of trade disruptions on different parts of the early manufacturing economy, such as domestic infant industries (e.g., cotton textiles) and trade-dependent industries (e.g., shipbuilding).

This index reveals that, on balance, the trade disruptions did not decisively accelerate U.S. industrialization; indeed, the trend growth in total industrial production is little changed over this period. However, the trend in aggregate industrial production masks a sharp divergence between the fate of infant industries (which boomed) and trade-dependent industries (which suffered). The United States entered the post-War of 1812 period with nearly 20 percent more infant industry production, and about 30 percent less trade-dependent industry production, than otherwise would have been expected. Yet our analysis suggests that the trade shocks have largely temporary effects on industrial production and therefore are not able to account for this permanent shift in resource allocation. Rather, shifts in the composition of domestic and

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15 was, for the time being, equivalent to extreme protection."

[2] Lebergott (1984, p. 126), Rosenbloom (2002), and others have observed the striking inverse correlation between shipping volume and incorporations of cotton textile firms. In addition, Sokoloff (1988) notes a small wave of patenting activity around the time of the trade disruptions.

international demand, the Tariff of 1816, and other factors may have been responsible for this reallocation between industries.

2. Trade Disruptions and Domestic Industries

At first, U.S. foreign commerce benefitted from the war that broke out between Britain and France in 1793. As a neutral country, American merchants quickly took advantage of the void left by the combatants in shipping goods from North America and the Carribean to Western Europe. U.S. re-exports boomed, growing from about $1 million in 1792 to nearly $40 million by 1800.[3] As the European hostilities intensified, however, the United States gradually became embroiled in the conflict. The British and French navies began harassing American merchants, confiscating their ships and cargoes, and impressing their sailors as each country sought to strangle the economy of the other.

In response, President Thomas Jefferson requested that Congress enact a trade embargo in December 1807. The embargo prevented U.S. ships from sailing to foreign destinations and its purpose was to prevent further losses to the merchant marine while denying Britain and France much needed supplies. Jefferson hoped that this "peaceful coercion" would convince the two powers to change their policy and respect neutral shipping. The embargo was a sharp blow to trade: imports for consumption fell 60 percent in 1808 from the previous year; a larger fall was prevented because American ships in Europe at the time the embargo was announced were allowed to return home and unload their cargoes.

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[3] Adams (1980) and Goldin and Lewis (1980) examine the impact of this booming re-export trade on the American economy.

Although domestic opposition forced the embargo to be abandoned just fifteen months later, in March 1809, a non-intercourse measure was then imposed banning trade with Britain and France for part of 1809. This was suspended for most of 1810, but in 1811 a non-importation measure was put in place against Britain. When these measures failed to ease tensions on the Atlantic, Congress declared war on Britain in June 1812. The conflict severely disrupted trans-Atlantic trade. The United States maintained its embargo against Britain, but a British blockade of the North American seaboard thwarted American attempts to continue trading with other parts of the world. The war and blockade almost completely eliminated U.S. foreign trade in 1813 and 1814. The value of U.S. imports for consumption fell from $70 million in 1812 to $13 million in 1814, a decline of over 80 percent. The Treaty of Ghent ended the conflict in December 1814 and normal trade was restored in the spring of 1815. The resumption of commerce brought a flood of imports into U.S. ports: imports surged to $79 million in 1815 and then $134 million by 1816, before falling back.

Figure 1 illustrates the volatile path of U.S. trade over this period by presenting the tonnage of ships engaged in foreign trade entering U.S. ports, perhaps the best measure of import volume during this time.[4] The tonnage of ships entering the United States fell 50 percent in 1808 from the previous year and fell nearly 90 percent between 1811 and 1814. U.S. import data are not sufficiently detailed during this period to provide a picture of how imports of manufactured goods were affected in particular, but it is likely that the United States was cut off from virtually

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[4] North (1966) presents a measure of real imports defined as the value of imports divided by a price index of imports. The real import series is highly correlated with shipping volume, but is more volatile and suggests the embargo did not a great impact on trade. The main reason we rely more on shipping volume as our measure of trade is concerns about the coverage and accuracy of North's import price index.

all foreign manufactured goods. Imports of manufactured goods came overwhelming from Britain, and the official value (real) British exports to the United States fell to extremely low levels from 1811 until 1815, as Figure 2 illustrates. The U.S. trade that did take place during this period was largely with countries in the Carribean rather than in Europe and thus probably did not consist of industrial products.

As noted in the introduction, the lack of economic data from this period has hampered efforts to determine how these severe trade disruptions affected early American industry. However, Davis's (2002) recently constructed index of industrial production for the 1790-1915 period provides a clearer view of the state of U.S. manufacturing during this time. This annual index incorporates 37 physical-volume series in the pre-Civil War period to gauge manufacturing activity in a manner similar to how the Federal Reserve Board's index currently measures U.S. industrial production. While Davis's original index possesses complete coverage from 1826 on, moderate attrition occurs further back in time. Consequently, we have constructed a version of the original Davis index whose coverage preserves comparability of index changes over time. Specifically, the special variant of the index includes only industries that existed on the eve of the embargo (and whose annual direct or indirect output measures were available before 1808) or that emerged as entirely new industries between the embargo period and the base 1850 census year of the index. These selection criteria retained 27 of the 37 original antebellum industries in the original Davis index, representing 61.4 percent of the value-added weight of the 1850 base year.

Figure 3 presents the industrial production index from 1790 to 1840. The shaded portions indicate the period of disrupted trade. While there appears to be some acceleration in industrial production around this time, it is not particularly pronounced. The lack of a distinct effect of the trade disruptions on total industrial production may be due to its differential, and perhaps offsetting, effects on different types of industries. For example, the highly controversial Jeffersonian embargo drew strong opposition from ship builders and fish preservers in New England, who were dependent on foreign trade, while new textile and glass manufacturers around Philadelphia supported the measure.

Indeed, while manufacturing was a very small part of the overall economy, it encompassed a variety of industries. This diversity is illustrated in a report on domestic manufactures by Albert Gallatin, President Jefferson's Secretary of the Treasury, in April 1810. Gallatin's (1810, p. 124) report distinguished between three categories of industry. The first category comprised eight commerce and trade-dependent industries: manufactures of wood (ships, furniture, etc.), leather, soap and tallow candles, spermaceti oil and candles, flaxseed oil, refined sugar, coarse earthenware, and powders (snuff, hair, etc.). The second category included eleven industries that were "firmly established" and supplied "a considerable part of the consumption of the United States" but still faced foreign competition in the domestic market: cotton, wool, and flax manufactures, iron, hemp products, hats and straw bonnets, paper and printed books, spirits and malt liquors, gunpowder, window glass, jewelry and clocks, lead, and wax candles. The third category consisted of seven industries in which some progress had been made in establishing domestic production, but where imports satisfied almost all domestic consumption: paints and colors, chemical preparations and medicinal drugs, salt, copper and brass manufactures, plated ware, calico printing, other earthen and glass wares.

The components of the Davis index can be separated into two categories – commerce and trade-dependent industries and domestic import-competing “infant” industries – that roughly correspond to Gallatin’s designation. (For our analysis, Gallatin’s second and third categories are combined because, on the eve of the embargo, few if any domestic industries were truly free from any import competition.) The 27 quantity-based components in this early American output index correspond closely with the 26 industries cited by Gallatin in his three categories of industry. Commerce and trade-dependent industries include merchant shipbuilding, refined sugar, sperm- and whale-oil refining, wheat flour milling, fish curing, whale bone and copper. Domestic infant industries include domestic cotton consumption (a proxy for textile output), newspaper circulation, coal production, hog packing, navy vessels, music organs, hand fire engines, firearms, salt production, army wool stockings, cloth regalia, and army boots and shoes. As would be expected of the early developing American economy, the values of the commerce and trade-dependent sub-index are larger than the sub-index of the domestic infant industries during the period under examination.[5]

Figure 4 shows the relative importance of these two categories and, more importantly, the markedly different effect of the trade disruptions on them. Trade-dependent industries were adversely affected by both the embargo and the wartime blockade, but much more severely by the latter. These trade-dependent industries experienced a drop in production of nearly 70 percent between 1811 and 1814. However, production quickly rebounded after the war. Among the domestic infant industries, there does not appear to have been much import substitution

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[5] In terms of 1850 value-added weights, the relative value-added weights are split rather evenly among Gallatin’s classifications of (1) trade-dependent industries (eight series, representing 32 percent of the index’s value added), (2) “firmly established” domestic industries (14 series, 27 percent), and (3) import-competing “infant” industries (five series, 41 percent).

during the 1807-1809 embargo, but a substantial amount during the war. Infant industry production nearly tripled between 1811 and 1814, but fell back once normal commerce resumed.

This separation reveals why total industrial production shows little sign of acceleration during this period. Any gains to domestic infant industries were largely offset by losses to trade-dependent industries, thus muting any pronounced impact on manufacturing overall. The trade shocks of the 1812 to 1814 period clearly had important, temporary effects on the distribution of industrial production across these differently situated categories, but did it have more permanent effects as well? Did the trade disruptions decisively accelerate production by import-competing industries or just boost their fortunes temporarily? And was the damage done to trade-dependent industries persistent or transitory as well?

3. The Effect of Import Shocks on Industrial Production

The main question that we seek to answer is whether the trade disruption had temporary or permanent effects on the component levels of industrial production. If trade shocks had transitory effects on production, then temporary protection from imports would boost the level of industrial production in the short-term, but it would then revert back to the level dictated by its trend growth. If trade shocks had permanent effects on production, then temporary protection from imports would lead to a persistently higher level of output.[6]

This section considers three different methods for examining different aspects of this

[6] For example, Rosenbloom (2002) argues that the expansion of U.S. textile production in the early nineteenth century is best understood as a path-dependent process initiated by the protection provided by the trade disruptions of this period.

question: unit root tests, linear trend regressions, and estimates of the reduced-form relationship between trade shocks and production.

A. Unit Root Tests

As a first pass at this question, we can test for a unit root (stochastic trend) in the industrial production indices. The unit root test helps indicate whether any random shock to production, without reference to trade shocks in particular, has permanent or temporary effects on the level of production. If the test fails to reject the hypothesis of a unit root, then the shocks to output are persistent and have a permanent effect on the level of production. If the test rejects the existence of a unit root, then the alternative could be that industrial production is characterized by temporary deviations from a deterministic trend, although rejection of a specific null hypothesis does not imply acceptance of any particular alternative.

Table 1 presents augmented Dickey-Fuller (ADF) unit root tests for the three industrial production series. The coefficient of interest is that on the lagged level of production (") and the null hypothesis of a unit root is that " = 0. If the absolute value of the t-statistic on " exceeds the ADF critical value, then the hypothesis of a unit root can be rejected. For total industrial production during the sample period 1790-1840, the ADF test statistic indicates that the hypothesis of a unit root cannot be rejected at the 5 percent level, i.e., we cannot reject the existence of a unit root in which some fraction of an innovation is permanent. Interestingly, for infant industry production, however, we can reject the hypothesis of a unit root. This goes against the path dependence or hysteresis story and is surprising because these are precisely the types of industries in which temporary protection might be thought to lead to permanent gains to output. In the case of trade-dependent industries, the hypothesis of a unit root cannot be rejected at the 5 percent level, but it can at the 10 percent level and the large size of the coefficient indicates that the series exhibits substantial mean reversion.

Perron (1989) argues that the conventional ADF t-statistic frequently accepts the null hypothesis of a unit-root when the true data-generating process is in fact trend stationary with a break in the intercept or the slope of the trend function. Thus, structural breaks in levels or trends in the series can bias tests against rejecting the null of a unit root. For reasons that will be discussed later, there may be a structural shift in the trend growth of overall industrial production in the early 1830s. Therefore, the second part of Table 1 examines the ADF test statistics for the period of 1790 to 1830. During this period, we can reject the hypothesis of a unit root in industrial production and in trade-dependent production at the 5 percent confidence level. Now, however, we cannot reject the hypothesis for infant production, although we can at the 10 percent level.

Thus, we conclude that the evidence in favor of a unit root in industrial production (i.e., that disturbances to production are permanent) is relatively weak but still uncertain.

B. Linear Trend Forecast

If innovations to production are not substantially permanent, then an alternative specification is to consider industrial production as stationary fluctuations around a deterministic trend with a stationary autoregressive component, such as:

(1) $$\log y_t = \mu + \beta t + \alpha \log y_{t-1} + \gamma_1 \text{ DISRUPTION} + \gamma_2 \text{ POSTWAR} + e_t$$

where y_t is industrial production, μ is a constant, t is a time trend, and e_t is a random error term. This specification includes two dummy variables that allow for shifts in the level of production during the embargo and blockade years (DISRUPTION, taking the value of one in 1808 and from 1812-1814) and during the post-war period (POSTWAR, which takes the value of one for the period from 1817 to 1840).

Table 2 presents the results from estimating this equation using the three industrial production series from 1791 to 1840. For total industrial production, in the first column, the coefficients on the dummy variables for the trade disruption and the post-war periods are small and not statistically significant. This indicates that the disruptions had little impact on the level of overall industrial production. However, the results are quite different for infant and trade-dependent industries. During the trade disruption period, infant industry production was 34 percent above, while trade-dependent production was 60 percent below, what might otherwise have been expected. After the war, the level of infant industry production was nearly 20 percent above what might have been expected prior to the war, while trade-dependent production was more than 30 percent below what would have been expected.

This regression suggests that infant industries came out of the war with a significantly higher level of production than might otherwise have been anticipated. A result of virtually the same magnitude comes from asking whether infant industry production was higher in 1820 or 1825 than one would have anticipated based on a simple linear extrapolation of its trend growth from the period prior to the trade disruption. Figure 4 illustrates this by comparing actual and predicted infant industry production based on a simple forecast of production using only a constant and time trend from 1800 to 1807. In this regression, the coefficient on time is 0.045, with a standard error of 0.007, with an adjusted R^2 of 0.89.[7] In 1820, actual infant industry

[7] Data from the 1790s is not used in this regression because the trend rate of growth was much higher during that decade; the coefficient on time from 1790 to 1807 is 0.12 with a standard error of 0.01.

production is 13 percent above the forecast production. For the period 1820 to 1825, on average, the actual is 15 percent above the simple forecast. In 1816, actual production is almost the same as predicted production, but imports were abnormally high in both 1815 and 1816 as trade was adjusting to the end of the war.

This evidence suggests that the United States emerged from the War of 1812 with a different allocation of resources between these two industrial sectors, but not more industrial production overall.[8] The next question is whether the change in industry composition can be linked to the trade disruptions themselves.

C. Effect of Trade Shocks

To examine the impact of trade disruptions on industrial production directly, we turn to some reduced-form estimates of the relationship between the two. In many ways, the question of how import shocks affect industrial production is analogous to how oil price shocks affect GDP, the subject of a much recent research. As described in Hamilton (2003), this analysis usually starts with a simple autoregressive distributed lag specification such as:

$$(2) \qquad \Delta \log y_t = \mu + \alpha \Delta \log y_{t-1} + \beta_0 \Delta \log (TON_t) + \beta_1 \Delta \log (TON_{t-1}) + \beta_2 \Delta \log (TON_{t-2}) + \varepsilon_t,$$

where y is industrial production, TON is the tonnage of ships engaged in foreign trade entering U.S. ports, and ε is a random error term. The coefficient β_0 captures the contemporaneous effect of the trade shock on industrial production. By recursive substitution, the effect of a change in

[8] We also tested for, but found no evidence of, a change in trend growth during those periods, i.e., it appears that the level of production was affected but not its growth rate. In addition, other variables, such as the average tariff rate or annual estimates of gross domestic product (a potential demand-shift variable), are not statistically significant and do not greatly affect these estimates.

tonnage at time t-1 on industrial production at time t can be represented as $"\$_0 + \$_1$, the effect of a change in tonnage at time t-2 on industrial production at time t can be represented as $"^2\$_0 + "\$_1 + \$_2$, the effect of a change in tonnage at time t-3 on industrial production at time t can be represented as $"^3\$_0 + "^2\$_1 + "\$_2$, etc. The sum of these effects gives us the total impact of a change in tonnage on industrial production.

Equation 2 is frequently estimated by ordinary least squares. However, a potential concern is that changes in industrial production and tonnage could be driven by a common factor, such as demand shocks. For example, an increase in domestic demand for manufactured goods could lead to an increase in imports and an increase in domestic production. Therefore, following Hamilton (2003), we attempt to isolate the component of the change in trade that can be attributed strictly to exogenous, non-demand factors – namely, the embargo and war – by creating a quantitative dummy variable for the change in the log of shipping tonnage for the years 1808 and 1812 to 1815. This quantitative dummy variable is not a zero-one variable, but one that takes the actual value of the change in those specific years and is zero otherwise. Because these shocks (all negative, except for 1815) are being driven strictly by American or British policy decisions, all are likely to be exogenous to other factors driving industrial production, such as demand or supply shocks. This quantitative dummy variable and its lags are used as instruments in an instrumental variables estimation of equation (2).

Table 3 presents the OLS and IV estimates of equation (2) for the effect of changes in shipping tonnage on total industrial production, domestic infant industry production, and trade-dependent production. The first two columns relating to total industrial production show that the coefficient on contemporaneous tonnage is not associated with any significant change in industrial production. The coefficient on lagged tonnage suggests that a ten percent reduction in shipping volume results in a 0.42 percent increase (OLS estimate) or a 0.47 percent increase (IV estimate) in industrial production in the next year. This implies a relatively modest effect, but obviously a larger and more prolonged disruption to imports would have a substantial impact on industrial output. The difference between the OLS and IV results is not substantial, suggesting that identification in the OLS case is really being driven by the few but large shocks around 1808 to 1815. The coefficient on the second lag on tonnage is very small and statistically insignificant.

The results are strikingly different for infant and trade-dependent industries. In contrast to the total industrial production regressions, the explanatory power of the regressions for these industries is very high, particularly for a first-difference regression. In the IV case for infant industries, the coefficient on contemporaneous tonnage indicates that a 10 percent decrease in tonnage increases production by 2.0 percent. However, the coefficients on the one and two year lags on tonnage carry the opposite sign of the impact coefficient and are sizeable enough to more than offset the initial impact of the shock. One year after a 10 percent negative tonnage shock, infant industry production is just 1.4 percent higher and two years after the shock it is essentially back to where it started.

In contrast, for trade-dependent industries, a 10 percent reduction in tonnage reduces output in these industries immediately by about 4.7 percent (IV coefficient). The coefficients on the lags are again the opposite sign of the impact coefficient, but the magnitude is less and the second lag is small and insignificant. The implication here is that, one year after a 10 percent negative tonnage shock, production by trade-dependent industries is 3.2 percent lower and two years after production is 2.4 percent lower.

Figure 6 depicts the dynamic forecasts of infant and trade-dependent production from a 10 percent negative tonnage shock at time t = 1. Due to the use of annual data and only two lagged values on tonnage, the responses are very choppy and do not display any new information beyond two periods after the shock (t = 3). But the figure does illustrate that, according to the results on Table 3, shocks to trade-dependent industries appear to be more persistent than in the case of infant industries.

As a check on these results, Table 4 presents estimates using the change in the log of real imports from Britain (i.e., the official value of British exports to the United States) instead of shipping tonnage. The British variable could be a better measure of imports of manufactured goods than overall tonnage because Britain was the source of most of those goods. The results are quite similar to those using tonnage, particularly with respect to the mean-reverting behavior of infant industry production to trade shocks. In results we do not report, we also used real imports from North (1966), which also yielded econometric findings similar to those in Table 2.

D. Interpretation

The previous subsection concluded that, from 1817, the United States had a level of infant industry production that was about 20 percent higher than one would have anticipated based on prewar trends. In addition, the level of trade-dependent industry production was about 30 percent lower than one would have anticipated. Although this description of the data was not directly tied to the trade disruption itself, it is very tempting to make that attribution. However, the results reported above tend to suggest that trade shocks have only temporary effects on the level of infant production and small permanent effects on the level of trade-dependent production.

If trade shocks themselves do not appear to be responsible for the permanent changes in the composition of industrial production, several other factors could have intervened in the immediate post-war period to alter the allocation of resources between infant and trade-dependent production. The two most likely candidates are the Tariff of 1816 and the changing composition of domestic and international demand. The Tariff of 1816 explicitly aimed to protect domestic industries from foreign competition and may have changed the structure of duties across goods to shift the composition of imports away from manufactured goods. Although Figure 1 shows that the volume of imports (shipping tonnage) returned to its prewar level by 1816, the measure of import volume here comprises all imports, not manufactured goods. Figure 2 indicates that import from Britain fell from 1815 to 1820 and then never reached their pre-war peak. For example, the value and volume of imports of cotton textiles from Britain was much lower in 1816 and 1817 than it had been in 1815 or even prior to the war, although whether this was due to the Tariff of 1816 or postwar economic difficulties is difficult to determine).[9] This might account for the path dependence that Rosenbloom (2002) argues was present in the case of cotton textiles.

Indeed, it should be noted that the effects of a trade disruption are not comparable to the effects of a tariff on imported manufactured goods. An import tariff could have targeted specific types of manufactured goods without disrupting trade overall or harming trade-dependent manufacturers in quite the way they were punished during this period. In addition, although it is commonly believed that the import surge of 1815 could have been prevented had the Tariff of

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[9] See Irwin and Temin (2001), Table 4 and Figure 5.

1816 been enacted more quickly, in fact imports in that year paid the higher wartime duties that were still in effect (but which had affected trade with Britain very little owing to the embargo and blockade).[10]

Another possible explanation for the compositional shift in industrial production is the change in domestic and international demand after the war. For more than a decade prior to the trade disruptions, Britain and France had been engaged in a protracted war. This war raised the demand for U.S. ships and other exported goods to abnormally high levels. After the war, as European demand for these products fell to normal levels, U.S. production in these trade-dependent industries fell permanently as well. Thus the decline in trade-dependent production was not a consequence of the trade disruptions themselves, but to a shift in foreign demand after the war. Similarly, with respect to infant industrial production, technological changes helped bring about a decline in household production of goods such as clothing and a shift to factory production, thereby raising domestic production permanently. Therefore, shifts in the composition of foreign demand and domestic household demand could plausibly account for some of the observed reallocation between trade-dependent and infant production.

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[10] In forming the tariff of 1816, Congress relied heavily on the report prepared by Alexander Dallas, the Secretary of the Treasury in the Madison administration. Like Gallatin's 1810 report, Dallas considered three classes of industry, (i) mature industries that were "firmly and permanently established" and supplied most of domestic consumption, (ii) industries "recently or partially established" which supplied part of domestic consumption but, "with proper cultivation, are capable of being matured to the whole extent of demand," and (iii) industries "so slightly cultivated as to leave the demand of the country wholly or almost wholly dependant upon foreign sources for supply." Examples from the first class included wood, hats, iron castings, window glass, leather, paper and printing. Examples from the second class included: course cotton and woolen goods, larger iron goods, and beer and spirits. Examples of the third class included: fine cotton goods, linens and silk goods, woollen blankets and carpets, china and earthenware, other glass products.

Neither the tariff nor the demand explanation is directly testable at this level of aggregation, so we are left with some ambiguity about the precise impact of the trade disruptions on the allocation of resources across manufacturing industries. We know that infant industry production was much higher after the war, and trade-dependent production was much lower after the war, but our results do not suggest that this is attributable solely to the trade shocks that confronted producers.[11]

However, a stronger conclusion is that the trade disruptions did not accelerate U.S. industrialization overall. Evidence consistent with this conclusion is that total U.S. industrial production relative to that of Britain (using the Crafts and Harley 1992 index) does not show a pronounced acceleration during the 1810s or 1820s. Rather, as Davis (2002) reports, U.S. industrial output surges in the early 1830s and again in the mid 1840s relative to that in Britain.

4. What Differentiated Successful and Unsuccessful Industries?

The quantitative evidence presented above can be supplemented with qualitative evidence on specific industries. This qualitative evidence is suggestive about some of the factors that differentiated industries that grew during the trade disruption and continued to flourish after the war from those that grew during the disruption but floundered in the postwar period, and from those that failed to grow at all.

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[11] In April 1816, Henry Brougham stated in Parliament that "it was well worth while to incur a loss upon the first exportation, in order, by the glut, to stifle, in the cradle, those rising manufactures in the United States, which the war had forced into existence, contrary to the nature of things" (quoted in Clark 1929, p. 240). This remark was widely noted in the United States and interpreted to mean that the import surges in 1815 and 1816 had been deliberate attempts to destroy U.S. manufacturers.

The industries that benefitted from the trade disruption tended to have low barriers to entry. In the U.S. context, these were industries that were not capital-intensive or have demanding technology requirements. In many instances, low barriers to entry also meant low barriers to exit, and thus some other element – such as the acquisition of technology or the accumulation or importation of human capital – was required to ensure the industry "stuck" in the United States after the flow of imported manufactures resumed.

The cotton textile industry is one that many have believed benefitted permanently from the stimulus of the trade disruption (see, for example, Rosenbloom 2002). The trade disruptions triggered large scale entry into the industry, particularly in New England. According to Gallatin's 1810 Report on Manufactures, the number of operational spinning mills grew from 15 before 1808 to 62 in 1809, with many more under construction.[12] The construction costs and technological requirements for setting up spinning mills was relatively low. But the most important change in the cotton textile industry around the trade disruptions, however, was the shift from simple spinning of yarn to mechanical weaving, particularly with the introduction of the power loom by the Boston Manufacturing Company, established in 1813 by Francis Lowell at Waltham, Massachusetts. By 1815, this technology produced cloth at half the price of hand woven cloth (Jeremy 1981, p. 101).

The adoption of the power loom ensured that many of the new entrants would be able to

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[12] According to Ware (1926, pp. 43-44), the short lived Jeffersonian embargo did not help the New England cotton textile industry much: "the increase of mill building during these years has led to the conclusion that the artificial stimulus of the embargo was responsible for the successful establishment of the cotton industry, but in the light of the fact that mills were forced by the destruction of their markets to curtail their expansion, dismiss some of their help, and struggle to dispose of the goods left on their hands, this conclusion ceases to be convincing."

survive the postwar trade competition. The question is whether the shift to power looms can be linked to the trade disruptions, or would the adoption of this technology have occurred in the absence of the disruptions anyway? According to Jeremy (1981, p. 93), "In 1812 the British were on the way to solving many of the technical problems of power weaving," which suggests that the United States adopted this technology as soon as it was ripe and ready. Although the profitability of power loom adoption was high due to the trade disruptions, the United States had previously acquired other British textile technologies relatively quickly during earlier period of normal trade. Thus, it is not evident that the trade disruptions were decisive. An indirect way in which the disruptions could have facilitated technology transfer is through the immigration of skilled workers from Britain, but the evidence on this is not conclusive.[13] (Even if the trade disruptions had not occurred, there was also ample room for an expansion of U.S.-based factory production at the expense of home production of clothing.)

A comparison of the New England and Philadelphia cotton textile industries suggests that the power loom was quite important to the survival of the industry. The New England industry adopted the power loom and easily survived into the post-war era, while the industry around Philadelphia boomed with the trade disruption but, lacking significant investment in power looms, withered once normal commerce resumed. The 1810 Census records that 206 looms were in operation in Philadelphia, but only 140 – of which just 65 were in operation – in 1820

[13] Jeremy (1981, p. 151) observes that, from 1809 to 1813, the rate of immigration by British textile machine-making workers increased from previous years, but notes that "the extent of the increase in the immigration of industrial workers between 1809-1813 and the 1820s may be magnified and distorted by . . . [the] disturbed Anglo-American relations prior to the War of 1812 [which] reduced earlier levels of immigration."

(Scranton 1987, p. 88).[14]

If technological adoption was an important factor in textiles, other industries failed because the requisite technology had not arrived on American shores. Pocket watches were very complicated products that were imported almost exclusively from Europe before the 1850s. Most advertised American "watchmakers" were in fact watch repairers or jewelry-makers. However, the embargo of 1807 encouraged Luther Goddard in Massachusetts to attempt to manufacture watches domestically in his repair shop. According to Bailey (1975, 190-5), Goddard made fewer than 500 watches between 1809 and 1817. The first watches made were of poor quality and took considerable time to build; he proved unable to compete effectively with European craftsmanship. Several decades passed before domestic production was firmly established.

In the case of medicines, low barriers to entry combined with domestic human capital to ensure the continuing success of the industry after trade resumed. The production of medicines required relatively little physical capital and was often a side business of physicians. Liebenau (1987, p. 11) notes that the foundation for the U.S. pharmaceutical industry was "laid between 1818 and 1822 with the establishment of several chemical manufacturers." America had been formerly dependent on British imports for medicine, but "with the economic disorder created by the war of 1812 and its aftermath, this pattern of dependence was broken." Liebenau observes that the manufacture of most common medicines was within reach for most apothecaries, as there was little need for capital investment and only a general knowledge of pharmacy required

[14] Textile employment fell from 3,500 in 1816 to just 400 in 1819 and just 200 in the Census of 1820. As a result, "Philadelphia millmen, by 1820, looked back on the midteens as a set of golden years," according to Scranton (1987, p. 76).

to produce basic remedies such as quinine sulphate, opium powders, and calomel. Production of these medicines were not capital intensive, but rather human-capital intensive. And Philadelphia had large concentration of well-educated German immigrant physicians and chemists, which contributed to the advances made by the industry at this time.

The glass industry – mainly engaged in the production of window glass – may also be one in which there were low entry barriers, but there was no special human capital or technological basis to production in the United States. Davis (1949, p. 37) estimates that the industry produced 5.0 million square feet of window glass in 1810 and just 5.4 million in 1820, not much of an advance. The industry expanded rapidly during the war, but "the end of the war not only put an end to rapid expansion of the glass industry but also brought distress to many of the glasshouses that had recently begun operations." Between foreign producers and the facilities build by domestic firms, the industry suffered from excess capacity and prices fell steeply from 1815. This price collapse may have erased much of the progress of the industry in the interim. Although there were more factories after the war than before – 22 in 1810 and 34 in 1820 – industry output cannot be equated with the number of firms.

Capital-intensive industries, especially those that depended upon domestic supply networks for productive inputs, were unable to mobilize resources quickly and take advantage of the disruption to imports. For example, the iron industry does not seem to have benefitted greatly from the temporary trade disruption. There is little indication that the industry experienced an output boom during the few years after 1810, but whatever expansion they did experience appears to have been short lived. There were fewer furnaces in Pennsylvania in 1818 than in 1810, according to Paskoff (1983, p. 75), and output was possibly lower as well. Even by the late 1820s the industry had not progressed much, perhaps because sufficient domestic demand was lacking to justify fixed investment in production or supply networks (until the railroads appeared on the scene).

Just as some of the production gains proved transitory for import-competing industries, so were the production losses for export-oriented industries. The shipbuilding industry clearly lost from the trade disruptions as construction fell from 146,691 gross tons in 1811 to 32,583 gross tons in 1813. The War of 1812 was "particularly disastrous for the shipbuilders; for there was little demand for tonnage, excepting small privateers; navigation was disrupted; and owners were frequently unable to pay for vessels already building," according to Hutchins (1941, pp. 185-187). "There is no evidence, however, that these fluctuations created such serious economic problems in the shipbuilding industry as were later to appear." Industry demand had been quite cyclical in the past and "both labor and master builders became accustomed to this oscillation, and developed alternative interests to which they could turn." Thus, when demand for ships boomed once again from 1815 until 1818, domestic construction quickly rebounded back to 155,579 tons. However, production remained relatively flat thereafter, well off of its prewar trend, although, as noted above, demand in the prewar period may have been artificially high due to the stimulus of war in Europe.

This brief survey of industry-specific evidence suggests the following conclusions. Industries that grew rapidly with the trade disruption and survived the onslaught of post-war British imports, such as cotton textiles and medicines, not only had low barriers to entry (i.e., were not capital intensive or technologically sophisticated) but had some human capital or technological basis that allowed it to be established and retained in the United States. Industries with low entry barriers lacking these human capital or technological attributes (such as glass) may have received a boost with the trade disruptions but retreated with the resumption of commerce. Industries that could not even get started despite the trade disruption were capital-intensive (iron) or technologically sophisticated (watches) or lacked requisite domestic suppliers.

6. Conclusions

This paper has analyzed the impact of the disruptions to U.S. trade between 1807 and 1815 on domestic manufacturing production. The trade disruptions did not accelerate U.S. industrialization in the sense that total industrial production was little changed by these events. Furthermore, the trade disruptions appear to have had large but temporary effects on production by domestic infant industries and trade-dependent industries. Yet because infant production was permanently higher and trade-dependent production was permanently lower after the resumption of normal trade, other factors such as the shifts in the composition of demand, technological change, and a different structure of manufactured imports under the Tariff of 1816 may have been responsible for this reallocation.

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Table 1: Augmented Dickey-Fuller Unit Root Test on Log of Industrial Production Series

Estimated Equation: $y_t = \mu_t + \beta t + \alpha y_{t-1} + \Sigma c_i \Delta y_{t-i} + e_t$

	1790 - 1840			1790 - 1830		
Series/Period	Industrial Production	Infant Production	Trade-Dependent Production	Industrial Production	Infant Production	Trade-Dependent Production
μ (t_μ)	0.36 (2.32)	0.33 (5.53)	1.76 (3.23)	1.48 (4.52)	0.34 (4.93)	2.65 (3.81)
β (t_β)	0.01 (2.07)	0.02 (3.53)	0.02 (3.25)	0.04 (4.46)	0.02 (2.29)	0.02 (3.11)
α (t_α)	-0.23 (2.04)	-0.33 (4.15)	-0.66 (3.26)	-0.95 (4.52)	-.030 (3.24)	-0.95 (3.81)
ADF 5% Critical Value	3.50	3.50	3.50	3.53	3.53	3.53

Table 2: Statistical Characteristics of Industrial Production

Dependent Variable: log of industrial production

Estimated Equation: $\log y_t = : + \$\, t + \text{"} \log y_{t-1} + (_1\, \text{DISRUPTION} + (_2\, \text{POSTWAR} + e_t$

	Total Industrial Production	Infant Industrial Production	Trade-Dependent Industrial Production
:	0.40* (0.13)	0.28* (0.06)	1.50* (0.53)
$\$$	0.012* (0.005)	0.010* (0.005)	0.022* (0.007)
"	0.75* (0.10)	0.74* (0.08)	0.44* (0.20)
$(_1$	-0.07 (0.06)	0.34* (0.11)	-0.60* (0.15)
$(_2$	-0.03 (0.05)	0.19* (0.07)	-0.31* (0.10)
Adj. R^2	0.99	0.98	0.87
LM (P^2)	3.37 (p = 0.18)	1.62 (p = 0.20)	2.99 (p = 0.22)

Notes: * indicates significance at the 5 percent level. Standard errors in parenthesis have been corrected for heteroskedasticity. Number of observations is 50 (time period is 1790-1840)

Table 3: OLS and IV Estimates of Effect of Shipping Shocks on Industrial Production

Dependent Variable: Change in log of industrial production

Estimated Equation: $) \log y_t = : + "\ ) \log y_{t-1} + \$_0\ ) \log (TON_t) + \$_1\ ) \log (TON_{t-1}) + \$_2\ ) \log (TON_{t-2}) + \ ,_t,$

	Total Industrial Production		Domestic Infant Industries		Commercial/Trade-Related Industries	
Constant	0.046* (0.014)	0.045* (0.014)	0.046* (0.022)	0.041* (0.019)	0.017 (0.017)	0.016 (0.018)
) log (IP_{t-1})	0.019 (0.176)	0.037 (0.179)	0.362* (0.198)	0.414* (0.191)	0.107 (0.164)	0.321* (0.173)
) log (TON_t)	0.011 (0.036)	-0.003 (0.034)	-0.212* (0.071)	-0.203* (0.063)	0.495* (0.065)	0.465* (0.061)
) log (TON_{t-1})	-0.042* (0.018)	-0.047* (0.015)	0.115 (0.081)	0.145* (0.069)	-0.165* (0.103)	-0.302* (0.092)
) log (TON_{t-2})	0.007 (0.013)	0.011 (0.016)	0.131* (0.034)	0.140* (0.027)	-0.034 (0.029)	-0.023 (0.030)
Adjusted R^2	0.07	0.06	0.58	0.58	0.80	0.79
	OLS	IV	OLS	IV	OLS	IV

Notes: * indicates significance at the 5 percent level. Standard errors in parenthesis have been corrected for heteroskedasticity. Number of observations is 49 (time period is 1791-1840)

Table 4: OLS and IV Estimates of Effect of Shocks to British Imports on Industrial Production

Dependent Variable: Change in log of industrial production

Estimated Equation:) log y_t = : + ") log y_{t-1} + $\$_0$) log (BM_t)+ $\$_1$) log (BM_{t-1}) + $\$_2$) log (BM_{t-2}) + , $_t$,

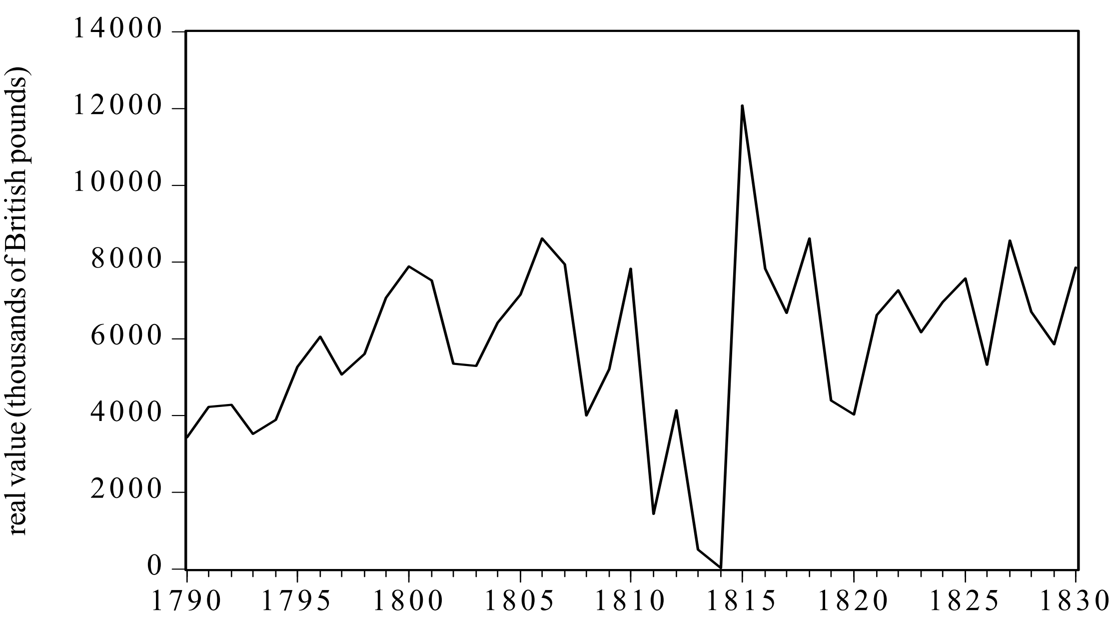
	Total Industrial Production		Domestic Infant Industries		Commercial/Trade-Related Industries	
Constant	0.047* (0.014)	0.047* (0.015)	0.040* (0.020)	0.043 (0.026)	0.023 (0.023)	0.019 (0.023)
) log (IP_{t-1})	-0.015 (0.190)	-0.012 (0.192)	0.431* (0.170)	0.394* (0.195)	0.122 (0.240)	0.070 (0.283)
) log (BM_t)	-0.004 (0.005)	-0.003 (0.011)	-0.041* (0.023)	-0.054* (0.029)	0.119* (0.021)	0.129* (0.028)
) log (BM_{t-1})	-0.010 (0.006)	-0.016* (0.006)	0.046* (0.026)	0.034 (0.031)	-0.040 (0.042)	-0.031 (0.053)
) log (BM_{t-2})	-0.002 (0.004)	0.000 (0.005)	0.043* (0.016)	0.042* (0.019)	-0.002 (0.016)	-0.020 (0.017)
Adjusted R^2	0.03	0.01	0.44	0.47	0.58	0.60
	OLS	IV	OLS	IV	OLS	IV

Notes: * indicates significance at the 10 percent level. Standard errors in parenthesis have been corrected for heteroskedasticity. Number of observations is 49 (time period is 1791-1840)

Figure 1: Tonnage of Ships Engaged in Foreign Trade Entering U.S. Ports, 1790-1830

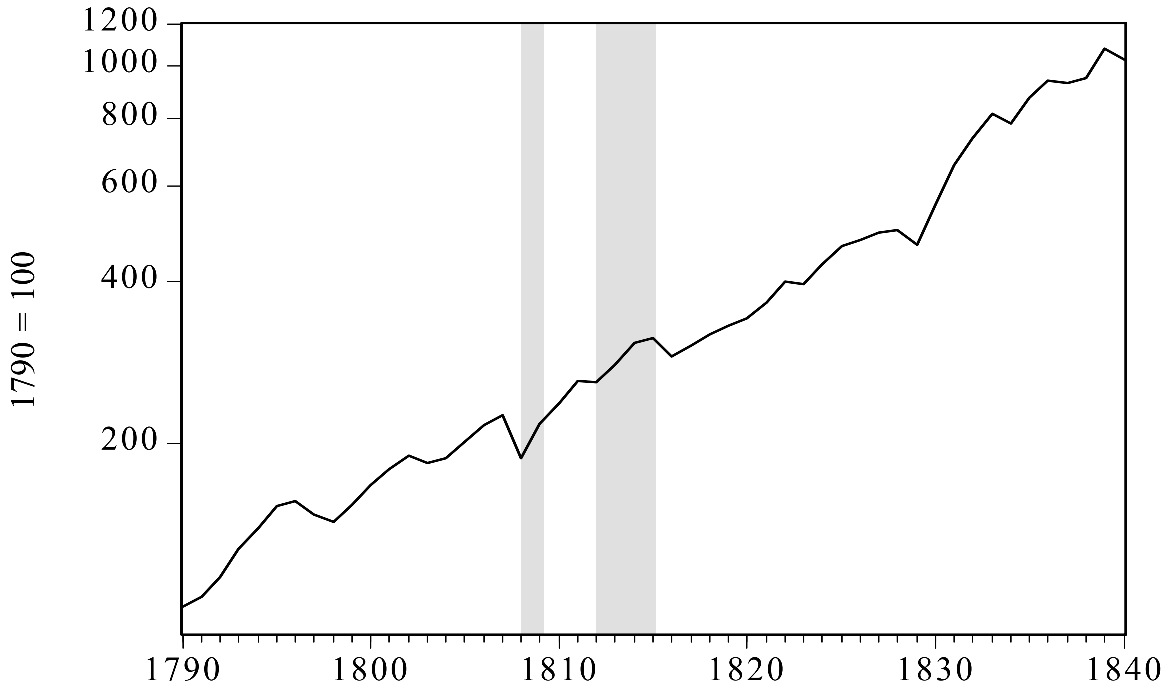
Source: U.S. Senate (1826).

Figure 2: Real British Exports to the United States, 1790-1830



Source: Mitchell (1988), p. 495.

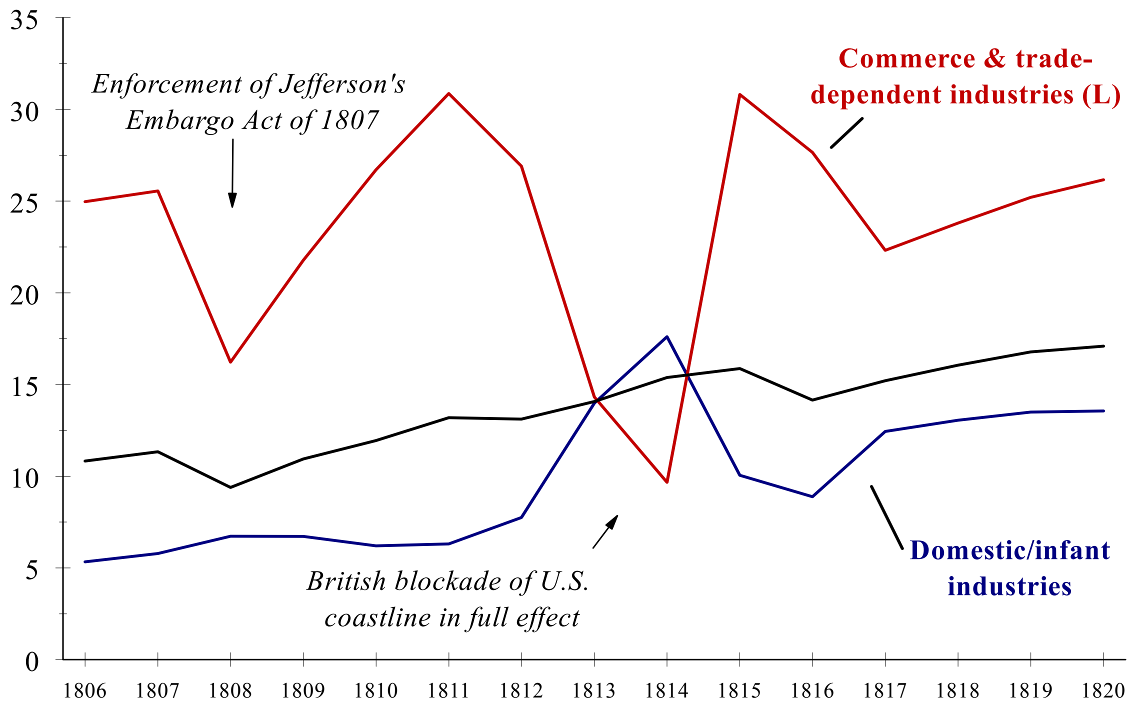
Figure 3: U.S. Industrial Production, 1790-1840



Source: Davis (2002). Shaded areas are periods of disrupted trade.

Figure 4

THE TWO FACES OF U.S. INDUSTIAL ACTIVITY SURROUNDING EMBARGO & WAR YEARS
(Indexes expressed in base year 1849/50 = 100)



Notes: Commerce and trade-dependent industries include merchant shipbuilding, flour milling, sugar refining, whale refining (3), fish curing, and copper consumption (these follow Treasury Secretary Gallatin's contemporaneous designations of industries dependent on foreign markets). *Domestic/infant industries* constitute all other [17] components of series beginning on or before 1808.

Figure 5: Actual and Forecast Production by Infant Industries

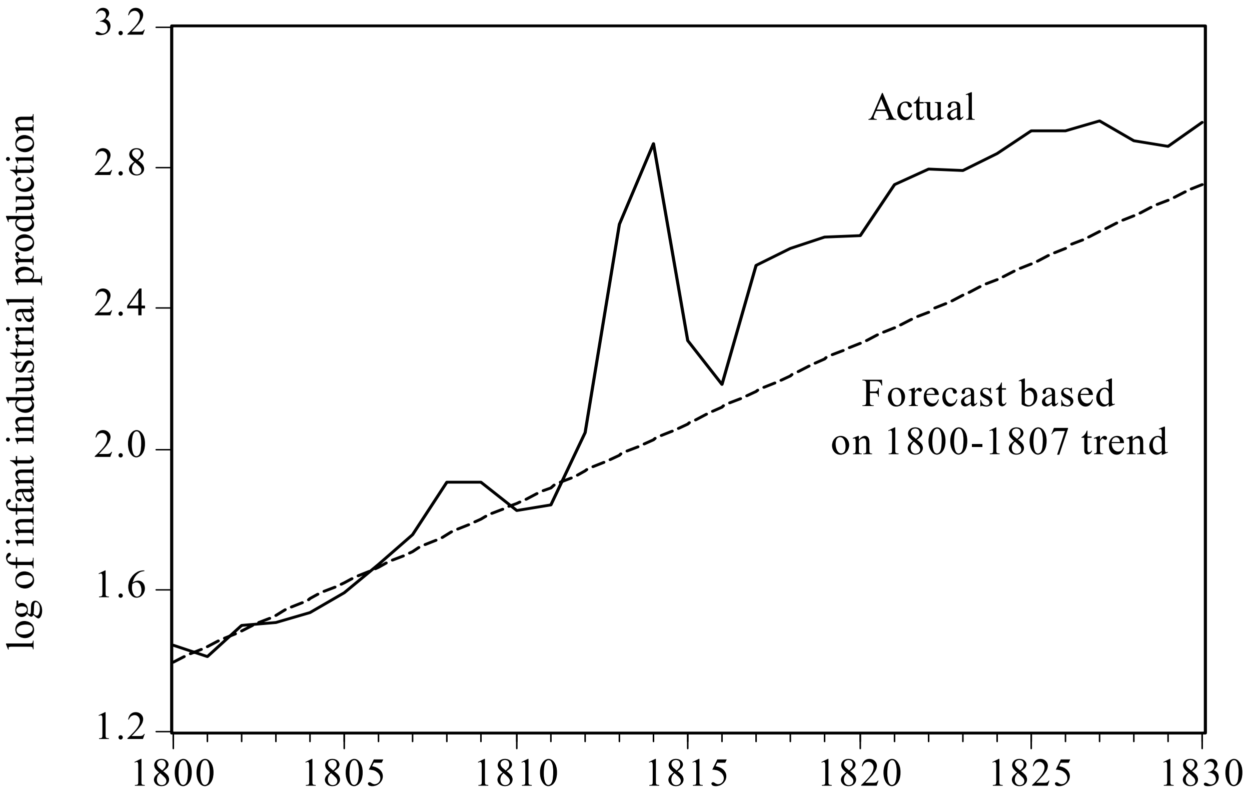
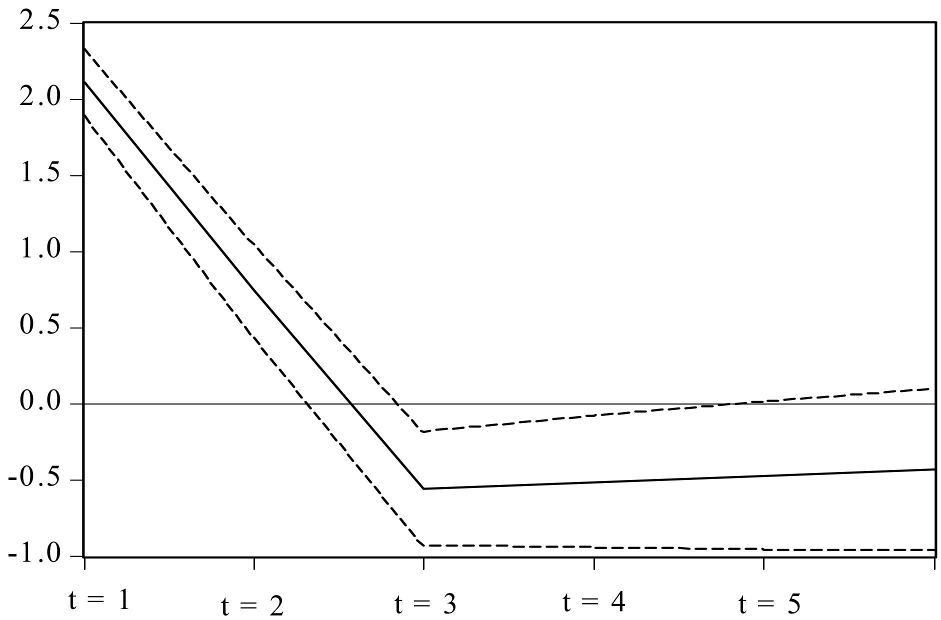


Figure 6: Dynamic Forecast of Infant Production to 10% Negative Shock to Shipping Volume

A. Infant Industry Production



B. Trade Dependent Production